

REMARKS

Claims 1-11 are present for examination. The examiner has indicated that claims 9-11 are allowed. Claims 1-8 stand rejected under 35 U.S.C. 103 as unpatentable over applicant's admitted prior art in view of Puskas (5,834,871). The examiner's rejection is respectfully traversed.

The examiner has recognized that applicant's admitted prior art does not disclose the plurality of amplifiers nor the plurality of flexible cables connected to the plurality of amplifiers and the plurality of head units. The examiner cites Figures 9A and 10 of Puskas to supply a teaching of multiple generators applied individually to multiple transducers. However, the Puskas reference is in the field of ultrasonic cleaning and the transducers are ultrasound transducers utilized to clean various materials placed within a liquid. This technology is completely different from the printhead technology in which piezoelectric transducers drive an ink jet printer. One of ordinary skill in the art would not be motivated to look at the ultrasonic cleaning technology when presented with problems in ink jet printing technology. Moreover, nothing within the Puskas reference itself would suggest utilizing the plurality of generators and individual plurality of transducers in an apparatus according to applicant's invention so that one would not be motivated, absent hindsight reasoning, in combining the two references as done by the examiner. As such, the Patent and Trademark Office has not made out a *prima facie* case of obviousness under the provisions of 35 U.S.C. 103.

Moreover, applicant's invention is not merely a case of duplicating "essential parts" because a person of skill in the art would not normally want to duplicate any amplifiers, nor flexible cables since such duplication would lead to more complexity and cost. However, applicant has determined that an excellent print image with high quality can be accomplished in accordance with the invention by distributing the total static capacitance of the piezoelectric elements to a plurality of power amplifiers. Thus, even if the resistance for the transmission pulse varies, the time constant is proportional to the static capacitance of the piezoelectric elements. Thus, the loss of the frequency components of the drive wave form signal due to the RC on the transmission path decreases. As a result, even if a

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plurality of piezoelectric elements are driven, the output signals of the power amplifiers are input to the piezoelectric elements without any deterioration and thus the piezoelectric elements can be driven effectively.

In view of the comments set forth about, it is submitted that the Patent and Trademark Office has not made out a *prima facie* case of obviousness and that the pending claims are patentable over the prior art.

The application is now considered to be in condition for allowance and an early indication of same is earnestly solicited.

Respectfully submitted,

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Date

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Attorney Docket No. 040447-0218

In re patent application of

Kyoichi NARIAI

Group Art Unit: 2834

Serial No. 09/576,492

Examiner: Karen B. Addison

Filed: May 23, 2000

For: PIEZOELECTRIC ELEMENT DRIVING CIRCUIT AND DRIVING METHOD

**MARKED-UP VERSION FILED WITH AMENDMENT IN RESPONSE TO
OFFICE ACTION OF DECEMBER 19, 2000**

Assistant Commissioner for Patents
Washington, D.C. 20231

Assistant Commissioner:

This is an amendment in serial number 09/576492 in reply to the Office Action mailed December 19, 2000. Please amend the above identified application as follows:

IN THE SPECIFICATION:

On page 1, delete the 3rd full paragraph, and replace this paragraph with the following:

The heads of the piezoelectric element driving type ink jet printers use electro-strictness of which mechanical distortion takes place with a crystal such as Rochelle salt or barium titanium in an electric field using ~~of~~ piezoelectric effect ~~of which~~ wherein the dielectric value of a crystal varies as a function of an electric charge on the surface thereof corresponding to an applied mechanical distortion. Using the characteristic ~~of which~~ that a piezoelectric element is deformed with a voltage, ink droplets are sprayed from nozzles of heads. Since the slope of the voltage and the potential are proportional to the acceleration and the intensity of the deformation of the piezoelectric element, by controlling them, the velocity and diameter of the ink droplets can be varied. Thus, to accurately control the acceleration and size of sprayed ink droplets, it is necessary to properly apply a voltage to the piezoelectric element.

On page 2, delete the 3rd full paragraph, and replace with the following:

Fig. 2 is a schematic diagram showing the structure of a printer apparatus including a printer head peripheral portion using piezoelectric elements 10. The printer apparatus comprises ink reservoirs 23, a carrier 22, a SP (spacing) motor 26, a shaft 24, an LF (line field) motor 25, a platen 28, and a flat flexible cable (FFC) 27. The carrier 22 ~~travels~~ moves heads (not shown) in the main scanning direction. The SP motor 26 drives the carrier 22. The shaft 24 is used to ~~travel~~ move the carrier 22. The LF motor 25 feeds paper 21 in the sub-scanning direction. The FFC 27 bends as the carrier 22 travels.

On page 2, delete 4th full paragraph, and replace with the following:

In the structure shown in Fig. 2, the paper 21 is fed in the sub-scanning direction by the LF motor 25, the platen 28, a feed roller (not shown), and so forth. The carrier 22 is ~~traveled~~ moved along the shaft 24 by the SP motor 26. A drive signal and a control signal are supplied to the heads through the FFC 27 so that ink droplets are sprayed to the paper 21 at a predetermined timing.

On page 3, delete 2nd full paragraph, and replace with the following:

In the carrier 22, the ink reservoirs 23 and the heads are connected with respective tubes (not shown). Inks in the ink reservoirs 23 are supplied to the heads. When the piezoelectric elements 10 are driven, they are deformed. Thus, the heads are partly stressed and thereby ~~inks~~ ink in the heads are partly sprayed from the nozzles. Consequently, an image is formed on the paper 21.

IN THE CLAIMS:

3. (Amended) The piezoelectric element driving circuit as set forth in claim 1, wherein the plurality of piezoelectric elements of the plurality of head units are vibrated so as to spray large ink droplets, middle ink droplets, or small ink droplets, and wherein when the small ink droplets are sprayed, the drive waveform signal is generated for a time constant that allows the number of piezoelectric elements that are simultaneously driven ~~becomes the~~ to become maximum.

4. (Amended) The piezoelectric element driving circuit as set forth in claim 1, wherein the head units are a yellow head unit, a magenta head unit, a cyan head unit, and a black head unit that spray yellow ink, magenta ink, cyan ink, and black ink, respectively,

wherein the head units spray large ink droplets, middle ink droplets, or small ink droplets of the individual colors corresponding to the number of piezoelectric elements of each of the head units connected to said plurality of power amplifiers and the level of the drive waveform signal, and

wherein when the small ink droplets are sprayed, the drive waveform signal is generated for a time constant that allows the number of piezoelectric elements that are simultaneously driven ~~becomes the~~ to become maximum.

5. (Amended) The piezoelectric element driving circuit as set forth in claim 2, wherein the plurality of piezoelectric elements of the plurality of head units are vibrated so as to spray large ink droplets, middle ink droplets, or small ink droplets, and wherein when the small ink droplets are sprayed, the drive waveform signal is generated for a time constant that allows the number of piezoelectric elements that are simultaneously driven ~~becomes the~~ to become maximum.

6. (Amended) The piezoelectric element driving circuit as set forth in claim 2, wherein the head units are a yellow head unit, a magenta head unit, a cyan head unit, and a black head unit that spray yellow ink, magenta in, cyan ink, and black ink, respectively,

wherein the head units spray large ink droplets, middle ink droplets, or small ink droplets of the individual colors corresponding to the number of piezoelectric elements of each of the head units connected to said plurality of power amplifiers and the level of the drive waveform signal, and

wherein when the small ink droplets are sprayed, the drive waveform signal is generated for a time constant that allows the number of piezoelectric elements that are simultaneously driven ~~becomes the~~ to become maximum.

7. (Amended) A piezoelectric element driving method for driving a plurality of piezoelectric elements disposed in a plurality of head units, each of which has a plurality of power amplifiers for driving the plurality of head units, a plurality of flexible flat cables for connecting the plurality of head units and said plurality of power amplifiers, and a drive waveform signal generating circuit for supplying a drive waveform signal to the plurality of head units, the method comprising the steps of:

driving the plurality of power amplifiers so as to amplify the drive waveform signal; and

causing the plurality of head units to spray large ink droplets, middle ink droplets, or small ink droplets corresponding to the drive waveform signal that is output from the drive waveform signal generating circuit,

wherein when the small ink droplets are sprayed, the time constant of the plurality of power amplifiers that are driven allows the number of piezoelectric elements that are simultaneously driven ~~becomes the~~ to become maximum.

10. (Amended) The piezoelectric element driving circuit as set forth in claim 9, wherein the plurality of piezoelectric elements of the plurality of head units are vibrated so as to spray large ink droplets, middle ink droplets, or small ink droplets, and wherein when the small ink droplets are sprayed, the drive waveform signal is generated for a time constant that allows the number of piezoelectric elements that are simultaneously driven ~~becomes the~~ to become maximum.

11. (Amended) The piezoelectric element driving circuit as set forth in claim 9, wherein the head units are a yellow head unit, a magenta head unit, a cyan head unit, and a black head unit that spray yellow ink, magenta ink, cyan ink, and black ink, respectively,

wherein the head units spray large ink droplets, middle ink droplets, or small ink droplets of the individual colors corresponding to the number of piezoelectric elements of each of the head units connected to said plurality of power amplifiers and the level of the drive waveform signal, and

wherein when the small ink droplets are sprayed, the drive waveform signal is generated for a time constant that allows the number of piezoelectric elements that are simultaneously driven ~~becomes the~~ to become maximum.